Wings of Victory,

Part 2

Technical Development during WW II

By Lee M. Pearson

During WW II, aircraft and equipment were manufactured in unprecedented numbers, shortcomings were corrected, and new designs were begun. The wings of victory grew from designs that were in existence at the beginning of the war, but others, with much greater capability, were nearing combat at the war's end. Areas that had been largely overlooked during the interwar years were hastily, but intelligently, entered – antisubmarine warfare (ASW) in particular. Newer technologies, such as radar, jet propulsion, guided missiles, rockets, and helicopters, were explored. Of these, radar was crucial. If the war had continued, other new fields would have increased in importance.

American aircraft production increased from 5,856 in 1939 to 26,277 in 1941 and peaked at 96,318 in 1944. Naval aircraft acceptances were: 1939, 303; 1941, 4,229; and 1944, 29,515. (1941 and 1944 figures include aircraft manufactured for the U.S. in Canada.) In 1938, French and British orders and money started the industry's expansion. After the fall of France in May 1940, President Roosevelt called for the U.S. to produce 50,000 planes a year. After the Pearl Harbor attack, he upped this to 60,000 planes for 1942 and 125,000 in 1943. These latter numbers were never met but served as goals and prods.

Production required decisions on types, numbers, designs, and delivery schedules of aircraft for the Army, Navy, and America's allies. The Joint Army-Navy-British Purchasing Commission came into being for that purpose in mid-1940. It became the Joint Aircraft Committee in April 1941, and finally the Aircraft Production Board. Subordinate elements included the Aircraft Resources Control Office and Aircraft Scheduling Unit. These organizations defined Army, Navy, and British needs for American aviation material and thus permitted orderly production plans and material and manpower allocations. In mid-1941, production cognizance was divided

Curtiss SB2C Helldivers were also manufactured by two Canadian companies as SBWs and SBFs.

between the Army and Navy.

Industrial expansion took many forms. Companies enlarged plants – usually with federal funds – expanded into leased space, and subcontracted. Plants were erected in areas that tapped new labor sources, and companies whose normal business was suspended "for the duration" became airplane builders. For example, Grumman's floor space at Bethpage, N.Y., was increased 25 times. It also leased available nearby space; despite that, subcontracting accounted for 27% of total output. Even more Grumman airplanes were needed. The General Motors Corporation, through its Eastern Aircraft Division, converted East Coast automobile assembly plants to airplane factories and built F4F *Wildcat* fighters as FMs and TBF *Avenger* torpedo bombers as TBMs. Eastern built about three times as many of these aircraft as Grumman.

New plants were erected at Columbus, Ohio, to manufacture Curtiss Navy aircraft and at Johnsville, Pa., north of Philadelphia, for Brewster. Engine production was similarly decentralized. Pratt & Whitney (P&W) engines were manufactured by five different automobile and small airplane engine companies. A P&W subsidiary operated a new plant at Kansas City, Mo.

Production seemed to be an end in itself as the phrase "production pipeline" indicated. Changes, whether for military utility or safety of flight, could not be made if they slowed deliveries. Thus, many new airplanes required modification before delivery to combat units. This was particularly true of the multiengine Army bombers that were converted to patrol planes. Air stations and other units were involved in such endeavors. Finally, as aircraft builders became adept at production management, they learned to introduce blocks of changes without delaying deliveries.

Prior to the war, only a single airplane was available to flight test a given configuration. If it crashed, testing and subsequent procurement were either delayed until a replacement could be built or, frequently, procurement was initiated without complete testing. This miserly approach was not necessary during the war; with airplanes streaming out of factories, many were available for flight testing modifications and design changes. As many as 100 fighters, and a comparable number of other types, were used at a time in various development and test projects.

In July 1941, a Navy Coordinator of Research and Development was established to improve intra-Navy research and development and to work with such agencies as the National Defense Research Council (NDRC). Dr. J. C. Hunsaker, who had headed the Navy Bureau of Construction and Repair's Aircraft Division during WW I and had directed the Bureau of Aeronautic's (BuAer) aircraft development until the mid-1920s, was first Coordinator. He then became Director of the National Advisory Committee for Aeronautics (NACA). As the Navy Department staff grew like wildfire, NACA was crowded from its space next to BuAer and moved about a mile away. Thus, the casual day-to-day contact of BuAer-NACA interwar relations was lost. Key employees, however, retained a residual understanding that contributed to solving the scientific and technical problems.

Research and development field activities grew apace. Flight testing, having outgrown NAS Anacostia, D.C., relocated in 1943 to the newly established NAS Patuxent River, Md. The Naval Air Test Center was established there in 1945. Naval Aircraft Factory (NAF) work became so diverse that in 1943 an overall command, the Naval Air Material Center, was established with subordinate units: the Naval Aircraft Modification Unit (NAMU), the Naval Auxiliary Air Station, and the Naval Air Engineering Station (NAES), as well as NAF. Within NAES were the Aeronautical Engine Laboratory, Aeronautical Radio and Radar Laboratory, and the Aeronautical Photographic Experimental Laboratory. A Ships Installation Division, which developed catapults and arresting gear, was reassigned from NAES to NAF.

After the Brewster factory at Johnsville was closed in 1944, NAMU relocated there; its primary role be-

Modifying PV-1 Venturas similar to that shown, the Marines pioneered night-fighter development and operations.

came the development of guided missiles. It was the forerunner of the Naval Air Development Center, Warminster, Pa. In November 1943, Naval Ordnance Test Station, Inyokern, Calif., was established to develop and test rockets and other weapons.

Experimental and developmental work were widespread. Special projects dealing with various aspects of airborne radar included: Project Roger, set up at NAF in May 1941 to test airborne radar; Project Affirm (originally Argus) set up in April 1942 at NAS Quonset Point, R.I., to develop and test night-fighter equipment and tactics; and Project Cast begun in April 1943 at NAS Squantum, Mass., to test radio and electronic equipment developed by NDRC's Radiation and Radio Research laboratories. Guided missile development involved NAF and naval air stations at Cape May, N.J., Traverse City, Mich., and Clinton, Okla.

On January 1, 1943, the Commander Air Force, Atlantic Fleet (AirLant) was established. Readying new airplanes, ships, and newly trained men, AirLant welded the air elements into combat-worthy units. In addition to training air groups and overseeing carrier shakedown cruises, AirLant tied together loose ends of airplanes and equipment. Through control of air stations, it was in the midst of the various aircraft modification programs. The Navy's overall lack of ASW experience gave AirLant an even more active role in that field. To help, the Air Anti-Submarine Development Detachment, Atlantic Fleet was established at NAS Quonset Point on April 1, 1943. In September, its mission was broadened as it became the Anti-Submarine Development Detachment.

BuAer was responsible for the various aviation material programs. Its engineering elements became a division that handled research, development, design, and evaluation: airplanes, engines, structures, instruments, catapults, arresting gear, etc. Guns, bombs, torpedoes, and rockets were developed by the Bureau of Ordnance. Radio and radar responsibilities were shared with the Bureau of Ships; the Naval Research Laboratory and NDRC's Radiation Laboratory shared actual development with the radio and electrical industries.

The Chief of BuAer reported to the Secretary of the Navy but advised the Chief of Naval Operations (CNO) on aviation matters. This proved adequate during the first year and a half of the war when production was the major problem. As war materials became available in quantity, the logistical problems of meeting fleet needs began to dominate. Logistical planning was a CNO function. Thus, in August 1943, a Deputy Chief of Naval Operations (Air) was established and five BuAer divisions were transferred to it. Military characteristics of aircraft and equipment involved consideration of technical feasibility and military needs; hence, they required a meeting of minds of engineers and planners in BuAer and DCNO (Air).

WW II aircraft were short-lived, with a 7 to 13-year service life, compared to modern machines that have service lives of 20 to 30 years. Advancing technology and military necessity caused designs to become obsolete. For example, the top speed of the F4F was about 330 mph; the F6F, 380 mph; and the various F4Us, 415 to 445 mph.

The foregoing surveys major areas involved in equipping the Navy with aircraft and material. We will now look in more detail at some particular areas: selected aircraft types, ASW, radar, guided misiles, and power plants.

Fighters

Four designs were used during the war: the Brewster F2A *Buffalo*, Grumman F4F/FM *Wildcat*, Vought F4U/FG/F3A *Corsair*, and the Grumman F6F *Hellcat*. The first two were in service in December 1941. F2A production ended in April 1942 and it was phased out of service after the Battle of Midway in June.

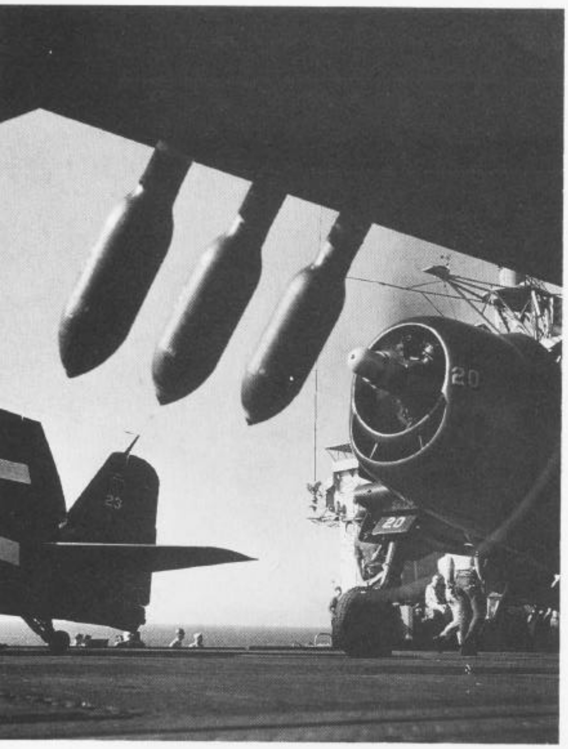
In December 1941, the fixed-wing F4F-3 was operational and the F4F-4, the first Grumman aircraft with folding wings, was entering production. The Japanese A6M *Zero* surpassed the F4F in speed, maneuverability, and climb rate. Despite that, the analysts that wrote the Commander in Chief, Pacific Fleet report of the Battle of Midway said that three *Zeros* were shot down for each F4F. Halving that to allow for over-optimistic claims, still leaves the F4F with an appreciable edge. As the analysts noted,"However much of this superiority may exist in our splendid pilots, part at least rests in the armor, armament, and leakproof tanks of our planes." By implication, this included the ruggedness that let the F4F continue flying after heavy battle damage.

The F4F was the Navy's main fighter for another year. In February 1943, the F4U began combat from shore bases and on August 31 the

Navy Multiple Source Aircraft Production

Designer/Designation		Multiple Sources/Designations	
Consolidated	PBY	Naval Aircraft Factory	PBN
		Vickers (Canada)	OA-10 (for AAF)
		Boeing (Canada)	PB2B
Curtiss	SB2C	Canadian Car & Foundry	SBW
		Fairchild of Canada	SBF
Grumman	F4F	Eastern Aircraft	FM
	TBF	Eastern Aircraft	TBM
Vought	TBU*	Vultee (later Consolidated Vultee)	TBY
	F4U	Goodyear	FG
		Brewster	F3A
	OS2U	Naval Aircraft Factory	OS2N
Brewster	SBA*	Naval Aircraft Factory	SBN

*Experimental prototype only, no production.



Robust, rocket-armed F6F Hellcats made excellent strike aircraft in the last year of the war.

F6F entered combat from fast carriers. Grumman installed a 1,350-hp engine in a new *Wildcat*, the XF4F-8 (earlier F4Fs had 1,200 hp); produced by Eastern as the FM-2, this airplane operated from escort carriers in both the Atlantic and the Pacific for the duration.

The F6F was begun in June 1940 when BuAer requested the R-1830 engine in the F4F be replaced with an R-2600. Grumman made a completely new design. The XF6F-1, with a 1,700-hp R-2600 engine, made its first flight in June 1942 and the XF6F-3, with a 2,000-hp R-2800 engine, flew in July. (The Navy recovered its first repairable Japanese *Zero* from the Aleutians in June; the near conjunction of dates disproves the oft-repeated myth that the F6F was based on a captured *Zero*.)

The F6F and F4U, begun in 1939, were the first-line fighters during the 1943-45 offensives. They were powered by 2,000-hp R-2800 engines. The F4U-4 used a 2,100-hp R-2800 "C" engine. Later F4Us and F6Fs had water-injection engines, as did the FM-2, permitting 10 minutes of increased power. Some were equipped with APS-4 search radar and others with APS-6 night-intercept radar.

Many changes were made to increase combat effectiveness of the F4U over the XF4U-1. To mention one, a self-sealing fuel tank in the fuselage replaced integral wing tanks. This required moving the cockpit aft and caused loss of vision that made the F4U unsatisfactory for carrier operations. A raised cockpit and longer tail wheel did much to overcome the problem. In January 1945, the F4U began regular sustained operations from carriers.

After the dive-bomber became a naval aircraft type in the mid-1930s, fighters were designed primarily as gun platforms. However, the strength and power that characterized the F4U and F6F enabled them to be readily modified to fighter bombers. Each could carry forward-firing rockets, two 1,000-lb. bombs, or a droppable fuel tank. The proportion of fighters assigned to fast carriers increased steadily from 25% of complement in 1942 to 50% in 1944 and to 70% in 1945. The dual role made this great increase in air-to-air combat power possible with little loss in carrier air-to-surface capability.

When the Germans' daytime bombing losses over England in 1940 became unacceptable, they switched to night bombing. Thus, before the U.S. entered the war, the British found radar-equipped night fighters to be necessary. In the Pacific, exhausted troops on Guadalcanal had their sleep disrupted by night hecklers – or "Washing Machine Charlies." Aviation forces had little success countering them with improvised night-fighting schemes and shore-based fighter direction. In late 1943, carrier pilots attempted to fend off night intruders with F6Fs flying wing on a TBF equipped with search radar.

Anticipating such needs, BuAer in September 1941 had asked NDRC to develop radar for single-seat fighters. In April 1942, a night-fighter development project (originally Project Argus, later Affirm) was established at NAF Quonset Point. In the meantime, the Marine Corps, following recommendations of observers who had studied British equipment and techniques, requested a twin-engine aircraft with AI (aircraft intercept) radar. The first Marine night-fighter squadron, VMF(N)-531, activated on November 16, 1942, eventually obtained a few twin-engine PV-1s and fitted them with the obsolete British Mk IV AI radar.

Project Affirm continued the single-place night-fighter concept and, in late 1942, NAF began modifying F4U-1s into F4U-2s by fitting them with AI radar from NDRC. On April 1, 1943, Navy squadron VF(N)-75 was established and Marine Night Fighter Group 53 was activated. Navy and Marine units deployed into the Solomons on October 31 and a pilot from VF(N)-75, aided by VMF(N)-531's ground-based fighter director, made a successful night interception.

An improved aircraft intercept radar, the APS-6, was used in the F6F-3N. Later, red-lighting instrument panels and a redesigned windshield improved the pilot's night vision, thus increasing effectiveness of the F4U-4N and F6F-5N. The above three models were used aboard carriers.

50 Years Ago — WW II

February 1: The Atlantic and Pacific fleets were established, completing the division begun in the previous November and changing the titles of aviation commands in the Atlantic Fleet to "Aircraft, Atlantic Fleet" and "Patrol Wings, Atlantic Fleet." No change was made in the Pacific Fleet aviation organization at this time.

February 15: Naval Air Station, Kaneohe, Oahu, T.H., was established.

February 26: An extensive modification of aircraft markings added National Star Insignia to both sides of the fuselage or hull and eliminated those on the upper right and lower left wings; discontinued the use of colored tail markings, fuselage bands, and cowl markings; made display of vertical red, white, and blue rudder stripes mandatory; and changed the color of all markings, except the national insignia, to those of least contrast to the background.

The usual method of increasing fighter performance was to increase engine power. This was true with the machines discussed above and with other developmental fighters. The Grumman F7F *Tigercat* increased power by using two rather than one engine; it was begun in 1941 and approved for production in 1943. A two-seat version with provisions for AI radar was built to meet Marine Corps night-fighter requirements.

The Grumman F8F *Bearcat*, begun in 1943, used the R-2800 "C" engine (also used in the F4U-4) in a machine somewhat smaller than the F4F. The goal was an interceptor to operate from both fast and escort carriers. Severe weight-saving features were employed, including a reduced safety factor and "safety wing tips" that would break away at ultimate load leaving it with reduced span and higher landing speed but still intact and flyable.

Both the F7F and the F8F were nearing combat introduction in August 1945.

Other new fighters used the R-3350 and R-4360 engines. Goodyear modified the F4U design into the F2G using the R-4360 engine. After the close of the war, they became surplus and some were acquired and used by racing pilots.

The Vought XF5U-1 had an almost circular wing and outboard propellers. It promised a top speed of almost 500 mph and vertical takeoff. An initial contract for the V-173 flying scale model was issued in February 1940, months before a Navy fighter achieved 400 mph. The military XF5U-1 was undertaken during the war. Maintaining balanced airflow required that the dual engines and propellers be interconnected. If that wasn't complicated enough, articulating propellers were also found to be necessary. The XF5U-1 was finally reported to be completed in 1948, but by then it had no military mission. To many BuAer engineers, its complex power transmission and control system seemed an Achilles heel; therefore, it was scrapped without having ever flown.

Meanwhile, jet engines had shown how to achieve 500 mph and much more. BuAer began studying jet fighters in 1942. Two small companies, McDonnell and Ryan, received the first jet contracts – McDonnell in January 1943 for the twin-jet XFD-1 and Ryan in March for the composite XFR-1. The XFD-1 used two Westinghouse 19B jet engines and was to determine requirements for carrier-based jet fighters. The XFR-1, powered by an R-1820 engine with a General Electric I-16 jet in the tail for takeoff and high-speed flight, was to be used on escort carriers. For fast carrier use, BuAer contracted with Curtiss for the XF15C-1 powered by an R-2800 engine and an Allis-Chalmers production model of the British H-1 Halford jet. A production contract was issued for 100 FR-1s; over two-thirds of them were delivered and one squadron was outfitted. As other engine combinations became interesting, Ryan received contracts for other composite fighters. All composite fighter programs were terminated in 1947.

The XFD-1 *Phantom* first flew on January 21, 1945, and 19 months later a *Phantom* became the first jet to operate from an American carrier, *Franklin D. Roosevelt*. The production model was redesignated FH-1.

In 1944, based in part on the promise of earlier designs and in part on the maturing of the wartime aviation industry, BuAer held its first wartime design competition – for a new fighter. Three new designs were selected for development, the Vought XF6U-1, the North American XFJ-1, and the McDonnell XF2D-1 (redesignated XF2H-1). With these three designs and the FD-1/FH-1, the Navy entered the jet age. ■

See the next issue for Part 3, the conclusion of "Wings of Victory."

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as landplanes to obtain the widest experience with the new airplanes. In March, a flight of the three seaplanes by steps to Miami ended at Morehead City, N.C., when one spiraled into shallow water from 100 feet during its landing approach. Fortunately, none of the three crewmen were seriously injured – viewed at the time as quite a contrast to similar accidents with typical wood and wire airframes. Another minor accident mid-month added to the continuing concern over the MO's suitability, and on March 27, flying was suspended for all fleet MO-1s except two of VO-6's which would be used along with the test airplane at Anacostia for finally resolving the MO problems.

Wind tunnel tests of possible new horizontal tail designs and flight testing of various changes to the wing and ailerons were followed by Martin's building a new tail, flown in November. VO-6 flew its airplanes extensively, both for tests of fixes and operational experience until turning them in in November. One of the airplanes at Hampton Roads was transferred to the National Advisory Committee for Aeronautics (predecessor of today's NASA) for its assistance on fixes.

By early 1925, all of the fixes came together, and resumption of flying was authorized. Unfortunately, some months earlier, in May 1924, BuAer had agreed that the smaller Vought UO-1 two-place seaplanes, powered by 200-hp Wright air-cooled radial engines, would be the standard battleship and cruiser "spotter." The battleship *Mississippi*, fitted with a turret-mounted gunpowder catapult, did operate two MOs during much of 1925-26. VJ-1 used three and both VS-2 and *Langley* had one or two assigned for short periods on the West Coast, while NPG Dahlgren, Va., also used one of the East Coast airplanes. By 1927, those in storage were considered unfit for service and most were donated to high schools, trade schools, and colleges over the next year; the rest were scrapped. The fleet had its "spotters" and a big step forward in aeronautical technology had been shown feasible. But the airplane that would have done both proved too big a challenge for its time. Not until 1940 would cantilever monoplane Vought OS2Us replace the traditional battleship/cruiser biplanes. ■

Although designed as floatplanes, land-based OS2Us provided vital ASW patrols along the East Coast and Caribbean.